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Land Subsidence in Delhi, India investigated using Sentinel-1 InSAR measurements

Shagun Garg^{1,2}, Mahdi Motagh^{2,3}, and Indu Jayaluxmi¹

¹Civil Department, Indian Institute of Technology Bombay, Mumbai, India (shagun@iitb.ac.in)

²Institute for Photogrammetry and Geo-Information, Leibniz University Hannover, Hannover, Germany

³Remote Sensing and Geoinformatics, GFZ German Research Centre for Geosciences, Potsdam, Germany

Groundwater induced land subsidence is a growing problem worldwide and has been documented in places like Mexico, Jakarta, Tehran, and China. India is the largest user of groundwater and pumps more than the USA and China combined. The National capital region (NCR) of India, due to rapid urbanization and illegal extraction, is facing severe groundwater depletion of the order of 0.5m-2m per year and is declared as a critical zone by the government of India. The looming crisis of groundwater depletion and supporting hydrogeology makes this region prone to land surface deformation.

Monitoring subsidence by conventional methods such as extensometers, leveling, hydrogeology modeling, and GPS requires precise field measurements and are time-consuming. With the advent of Interferometry, monitoring deformation precisely from the microwave sensors onboard satellite is possible. In our study, we demonstrate the result of the Persistent Scatterer InSAR (PS-InSAR) technique to monitor the subsidence in the Delhi NCR region using Sentinel -1 Interferometric wide swath (IW) mode. Descending pass datasets are used to identify the PSs over the study area. Fifty-six differential interferograms from Aug 2016 to Sep 2018 are formed after removing flat earth and topographic phase using SRTM 30m DEM. The PS-InSAR processing is done using Stanford Method for Persistent Scatterers (StaMPS), where an amplitude threshold index of 0.4 is selected for Initial PS candidate. The PS points are the stable targets which do not decorrelate much over time. The deformation is calculated for all these PS points and a time series, and hence a velocity map is formed.

The rate of deformation in Southwest Delhi is found to be approximately 15 cm/year (max) in the radar line of sight direction. The in-situ data provided by the Central groundwater board (CGWB) India is not consistent and has many gaps. However, after applying Spatio-temporal interpolation, it follows the decreasing trend of Land subsidence which suggests that the groundwater extraction is the major cause for the subsidence in the southwest region of NCR during the observed period i.e., from 2016 -2018.